Reliability Oriented Methodology For Wind Turbine Operation

2nd Wind Turbine Reliability Workshop

Jordi Roca

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FIRST WIND TURBINE

1985

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FIRST COMMERCIAL WIND FARM IN SPAIN

1992

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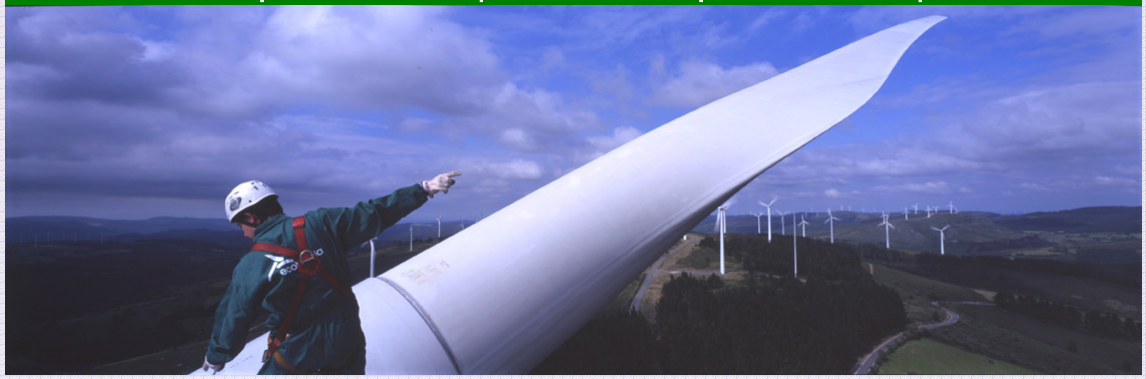
Evolution of the Workforce

2003	2004	2005	2006	2007
299 employees	530 employees	625 employees	680 employees	727 employees



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WIND FARMS

- *1730 MW Total installed power*
- *519 MW Under construction end 2007*
- *550 MW Forecast 2008*

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50% OF OUR SALES ARE EXPORT

2006

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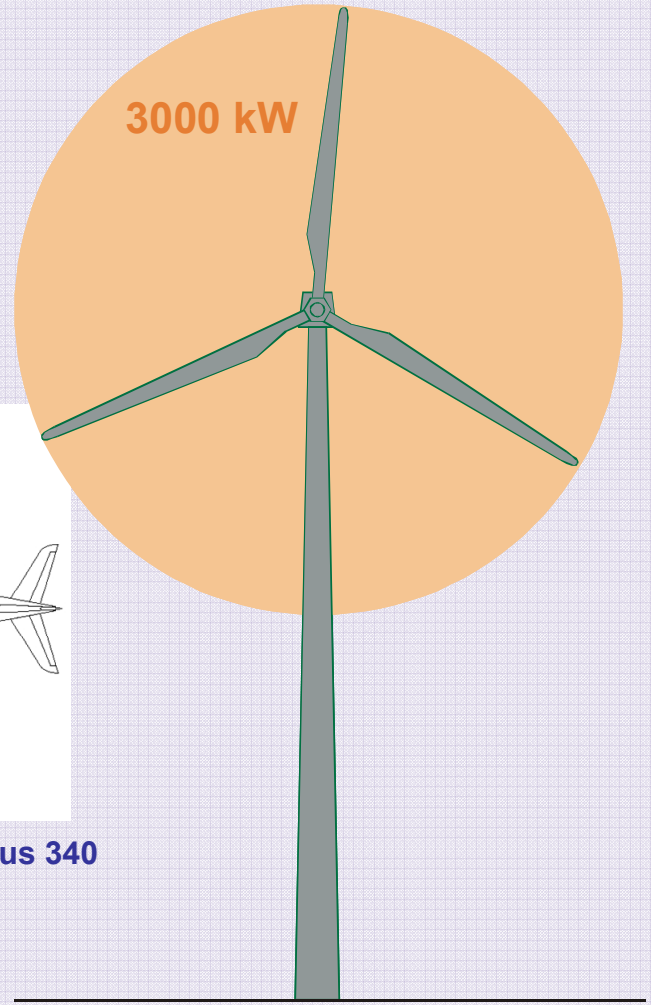
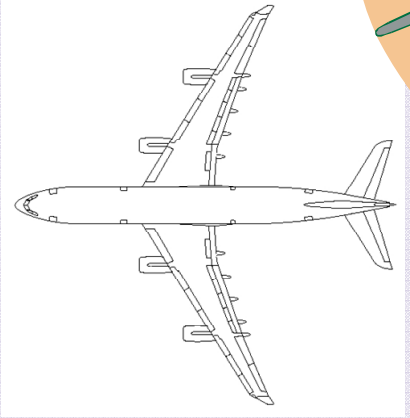
NOW ASSAMBLING 3 MW, 100 m. dia.





Compared with an Airbus 340

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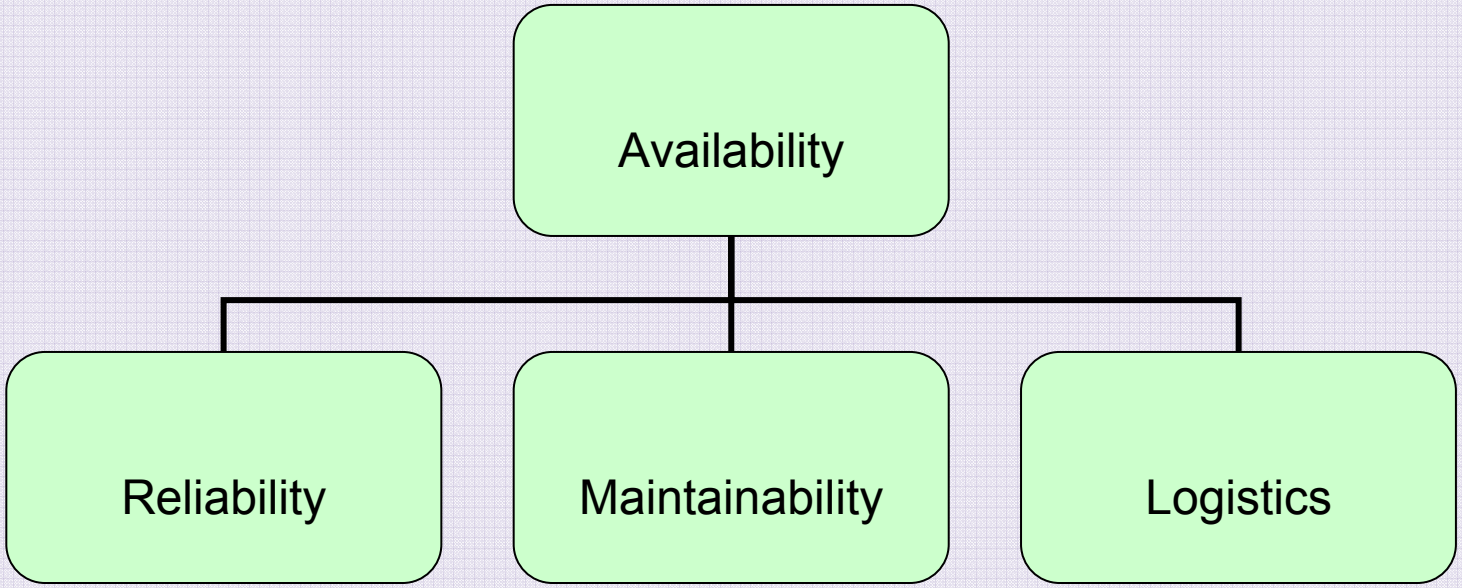
Availability Relationships



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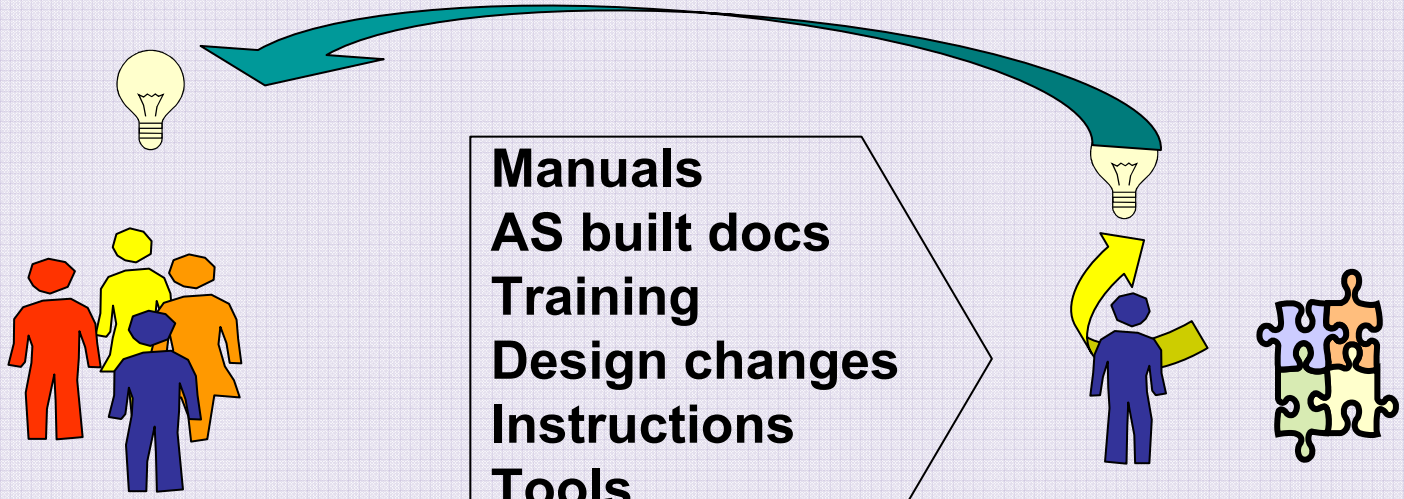
Maintainability



Design & Reliability

Operation & Maintenance

Set correct feedback, support diagnostics, provide assistance and distribute knowledge

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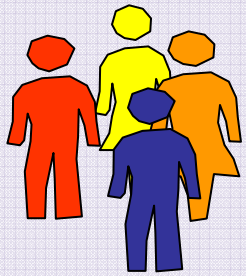
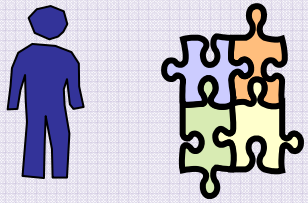
Logistics



Operation management
Supply chain

Parts
Skilled people
External support
External services
Logistic units



Operation &
Maintenance

Not stop operation because of lack of available parts, people and services

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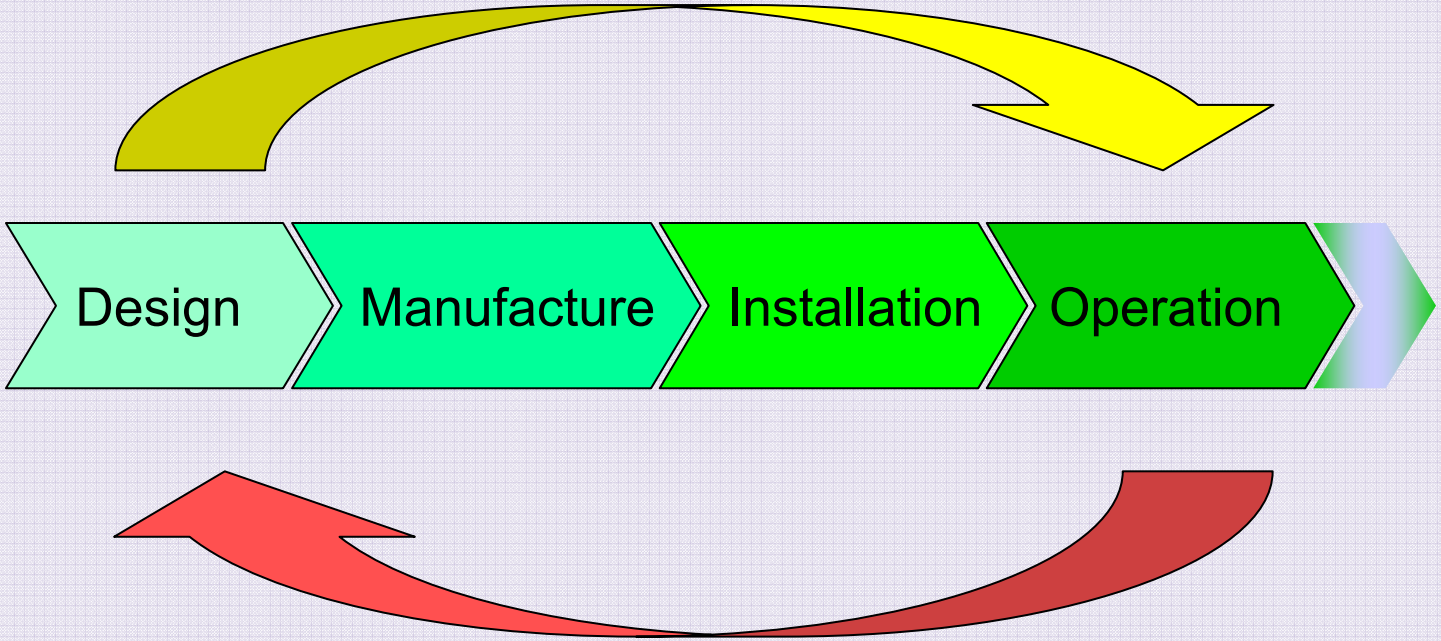
Reliability

Direct improvements



Feedback of experience to design team

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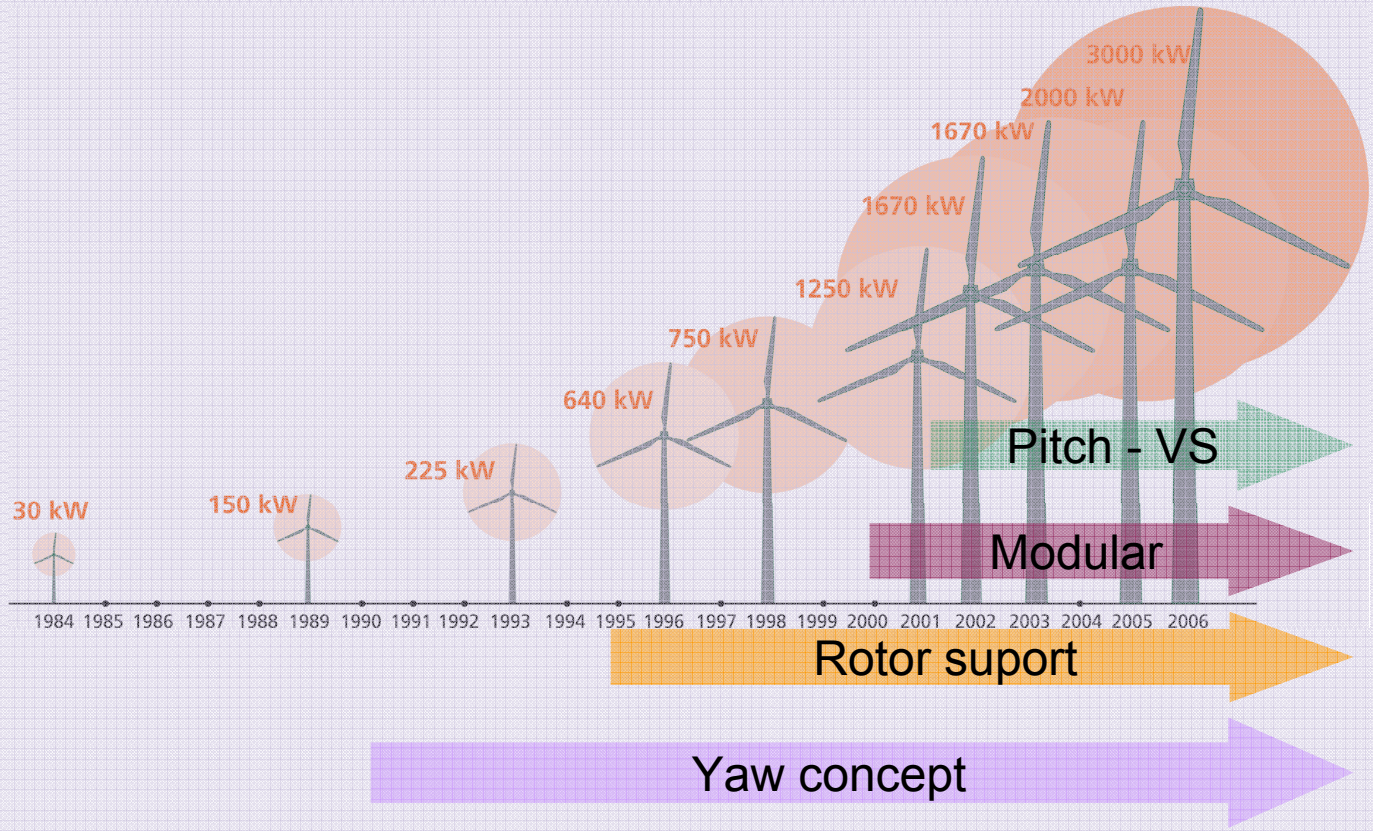
Complexity



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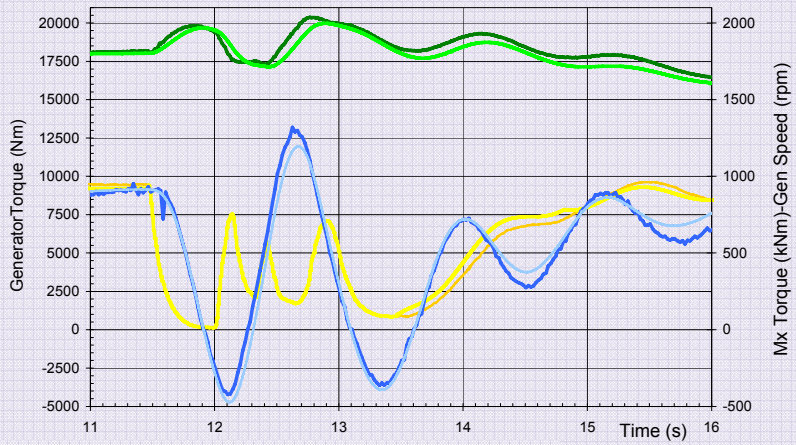
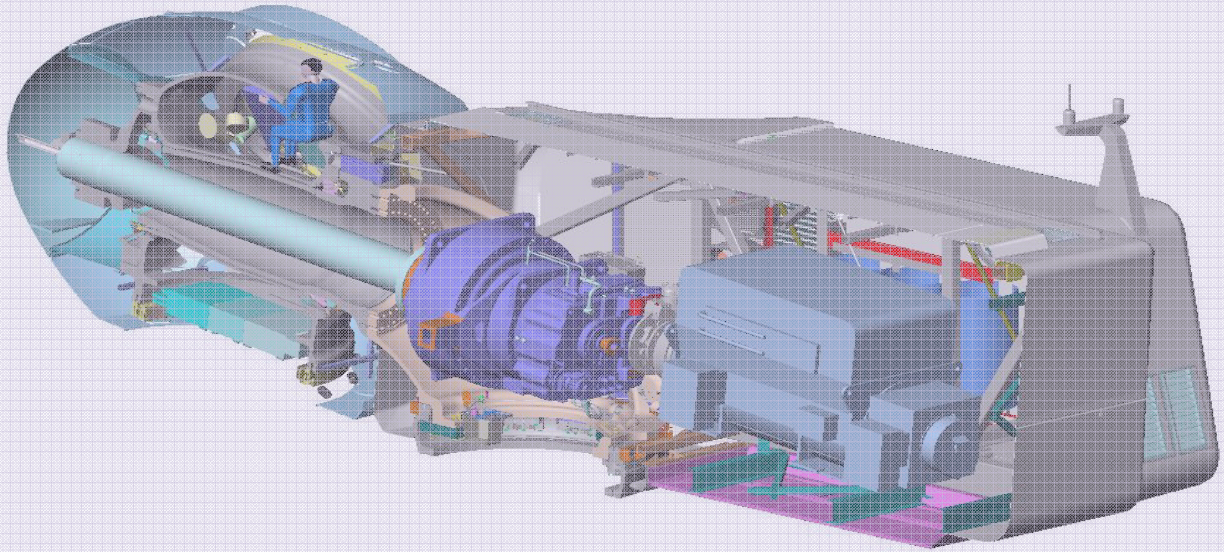
Reliability oriented design





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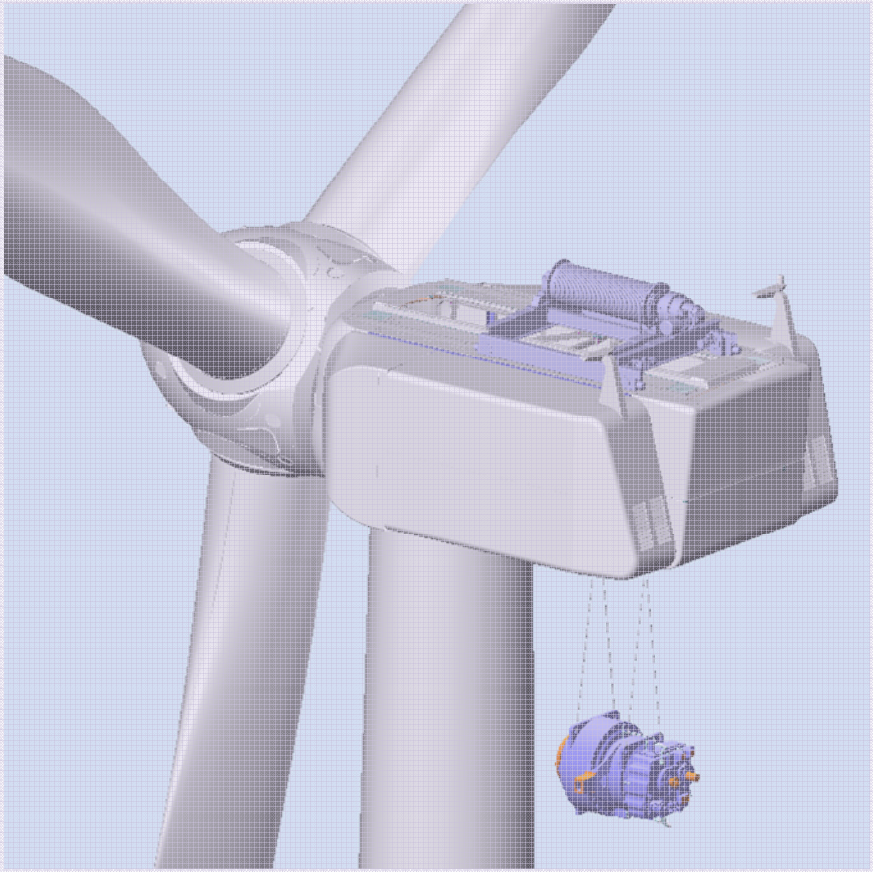
Maintenance oriented design



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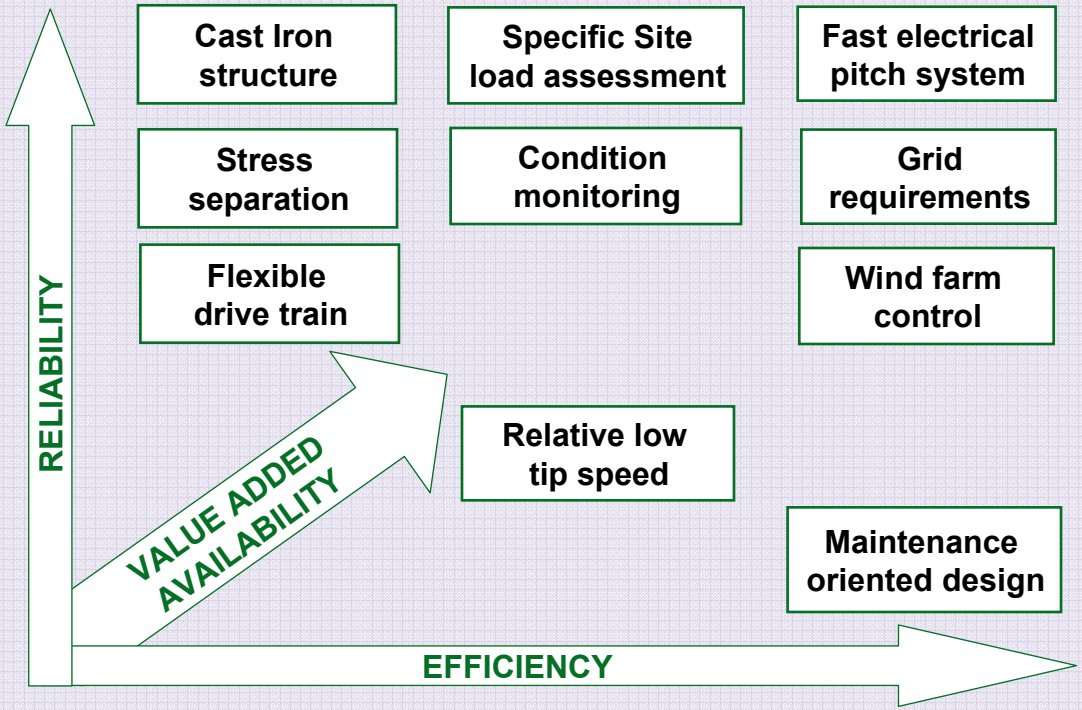
Product attributes oriented to added value and availability



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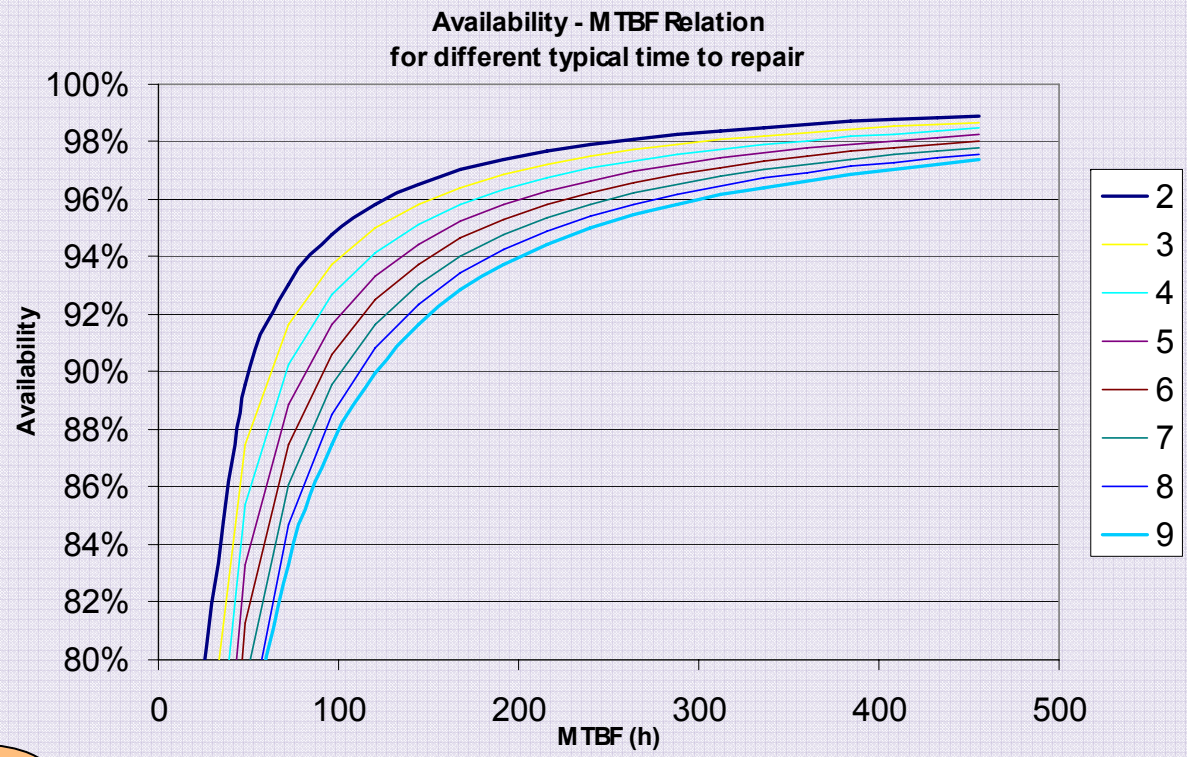
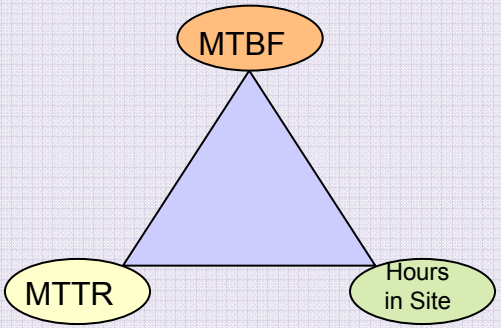
Statistical relation





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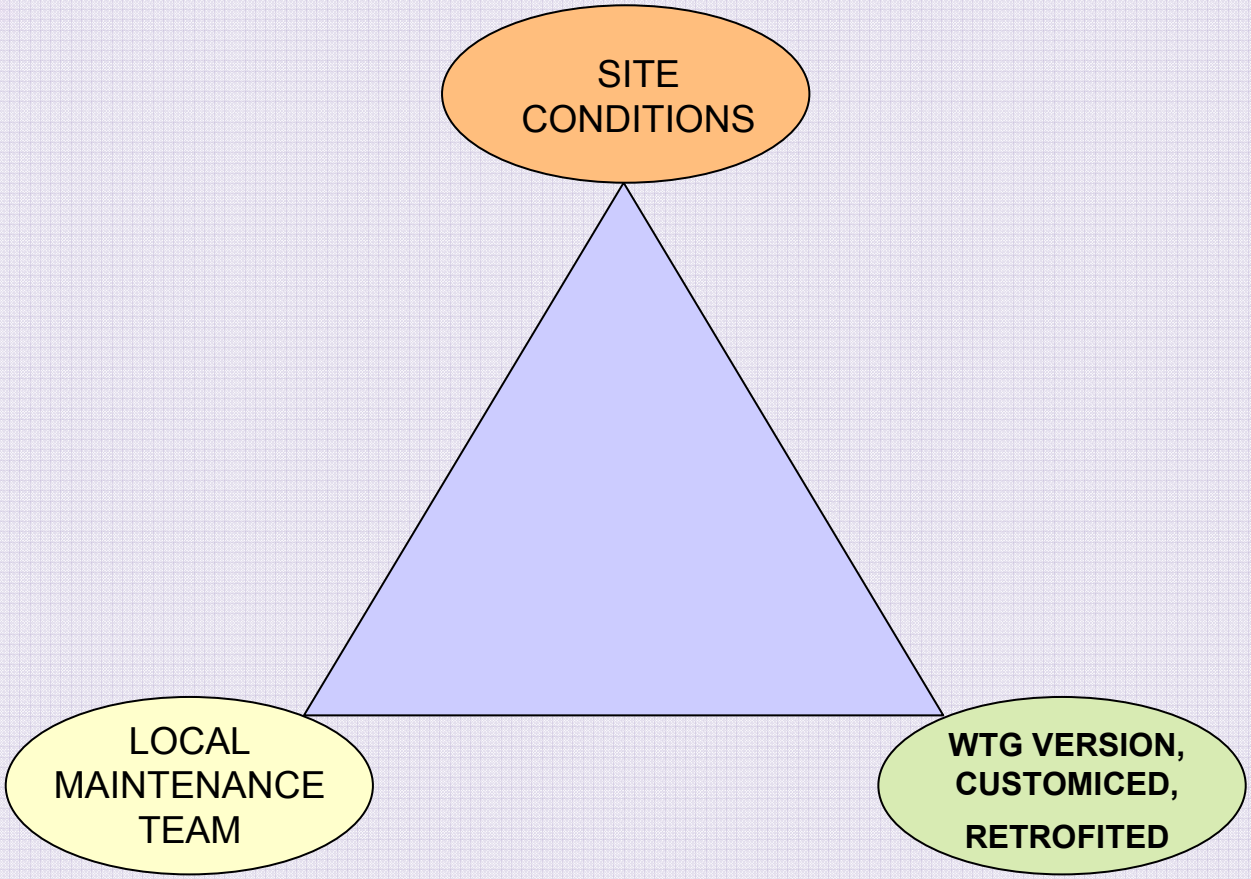
Complex environmental effects



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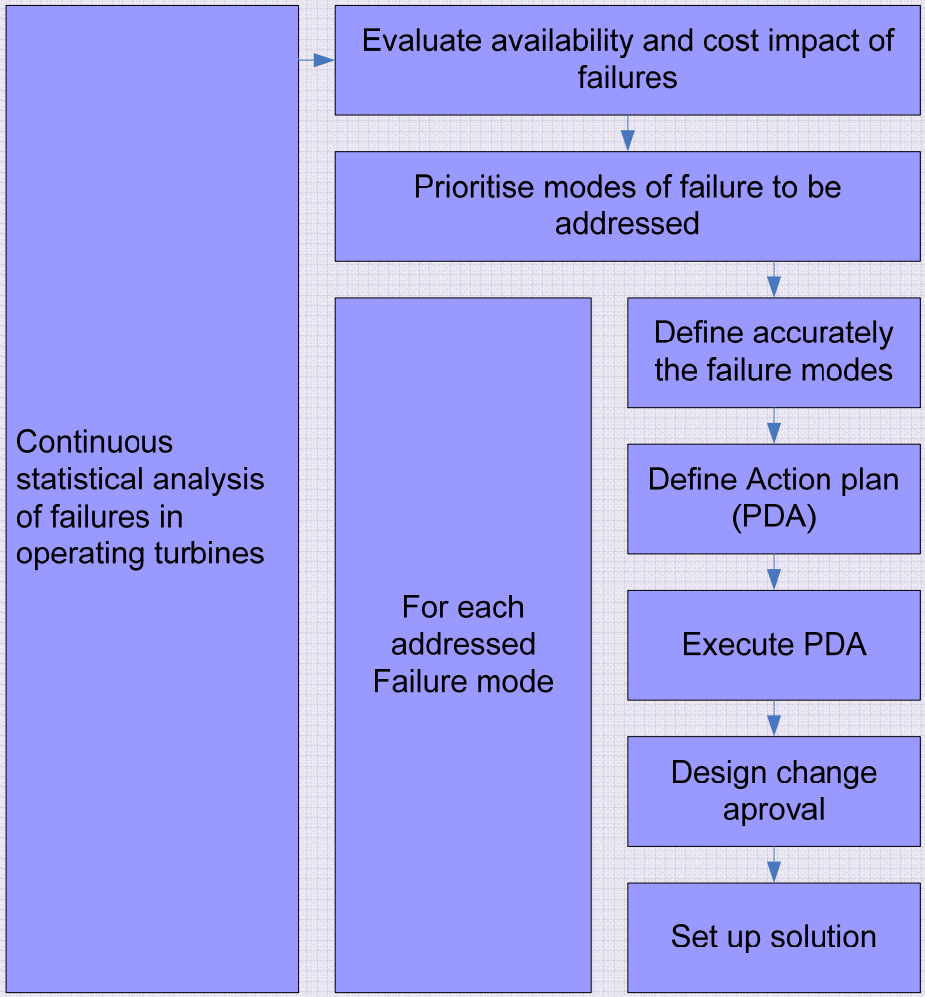
Procedure Diagram



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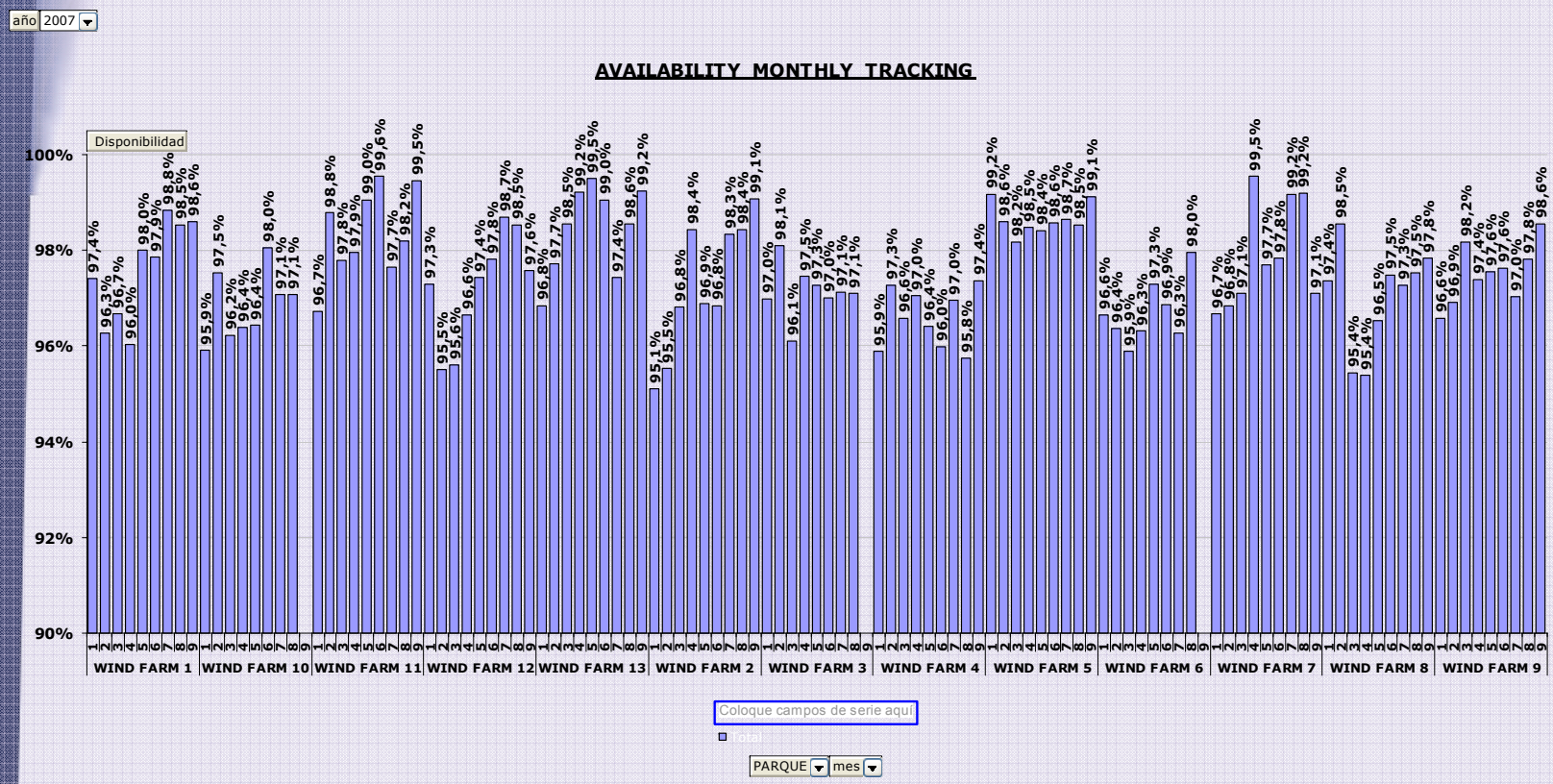
Data collection



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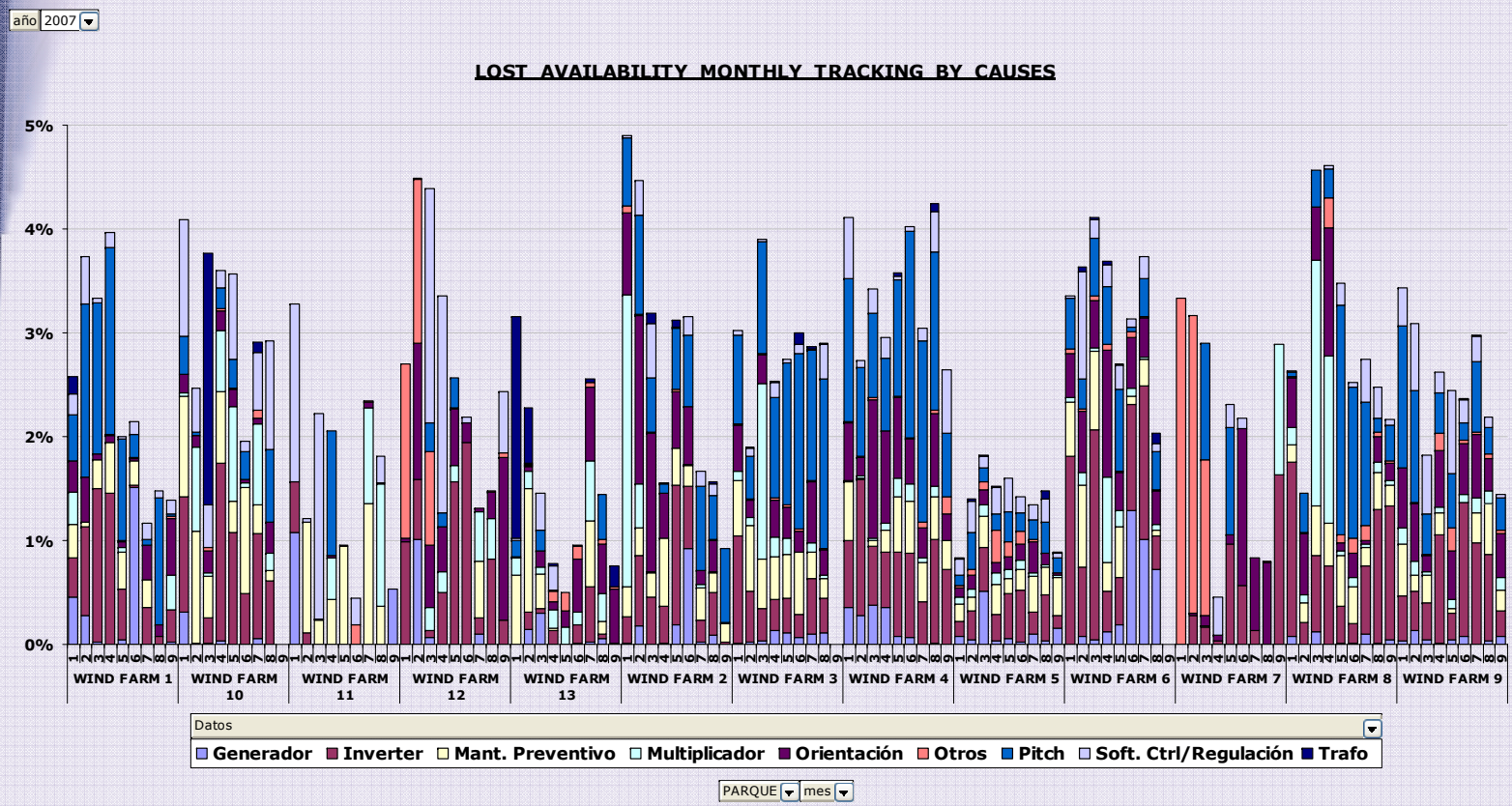
Data analysis



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Detailed Failure Modes for any system

System	Converter		151
Setmana/mes	April 06	Days	30

Parc	WF 1	WF 2	WF 3	WF 4	WF 5	WF 6	WF 7	WF 8	Total
Number of WTG	7	21	34	30	80	30	15	2	219
Serial	1	1	1	1	2	2	3	3	
Availability lost by the system	**0,34%**	**0,13%**	**1,64%**	**0,27%**	**1,05%**	**1,79%**	**2,10%**	**1,17%**	**1,10%**
Stop hours	17,1	19,7	**401,5**	**58,3**	**606,0**	**387,5**	**226,8**	16,8	**1733,7**
Hours / WTG.	2,4	0,9	11,8	1,9	7,6	12,9	15,1	8,4	7,9
Target	*0,40%*	*0,40%*	*0,40%*	*0,40%*	*0,50%*	*0,40%*	*0,40%*	*0,40%*	*0,44%*
Target hours	*20,2*	*60,5*	*97,9*	*86,4*	*288,0*	*86,4*	*43,2*	*5,8*	*688,3*

	Modes of failure	0,34%	0,13%	1,64%	0,27%	1,05%	1,79%	2,10%	1,17%	1,10%
151.A	errors management - autoreset : ***underline volt / underline volt / overvoltage, low voltage R,S,T + overcurrent stator + interruptor ppal, overcurrent rotor, overcurrent stator, invereter overspeed***	0,00%		0,01%		0,160%	0,790%	1,35%	1,070%	*0,27%*
151.B	service, training, stock speaparts									*0,00%*
151.C	***mcb ack & mcb rdy flt***	0,32%		0,35%	0,21%	0,01%		0,43%		*0,13%*
151.E	***invereter overspeed***									*0,00%*
151.G	***isu shortcircuit***						0,28%	0,16%		*0,05%*
151.H	***isu charg / dc undervoltage / crowbar + rotor gate driver***			0,84%						*0,13%*
151.I	***dc overvoltage / crowbar***					0,13%	0,10%			*0,06%*
151.J	***inverter coms, rotor gate driver***		0,05%	0,20%	0,02%	0,23%	0,03%			*0,13%*
151.K	***overcurrent rotor, overcurrent ISU***	0,02%		0,01%		0,263%	0,060%			*0,11%*
151.L	tancar tapa carcassa amb convertidor abb acs800-67					0,05%				*0,02%*
151.P	fiabilitat convertidor ABB - root causes components canviats (components diversos)									*0,00%*
151.Q	***encoder error***			0,08%			0,03%			*0,02%*
151.R	***INU overtemp***						0,01%			*0,00%*
151.S	***¿ISU start*** ?									*0,00%*
151.T	**INU Earth**					0,04%	0,24%	0,16%		*0,06%*
151.U	**Other (generic) Inverter Error**		0,08%	0,15%	0,04%	0,17%	0,26%		0,10%	*0,13%*

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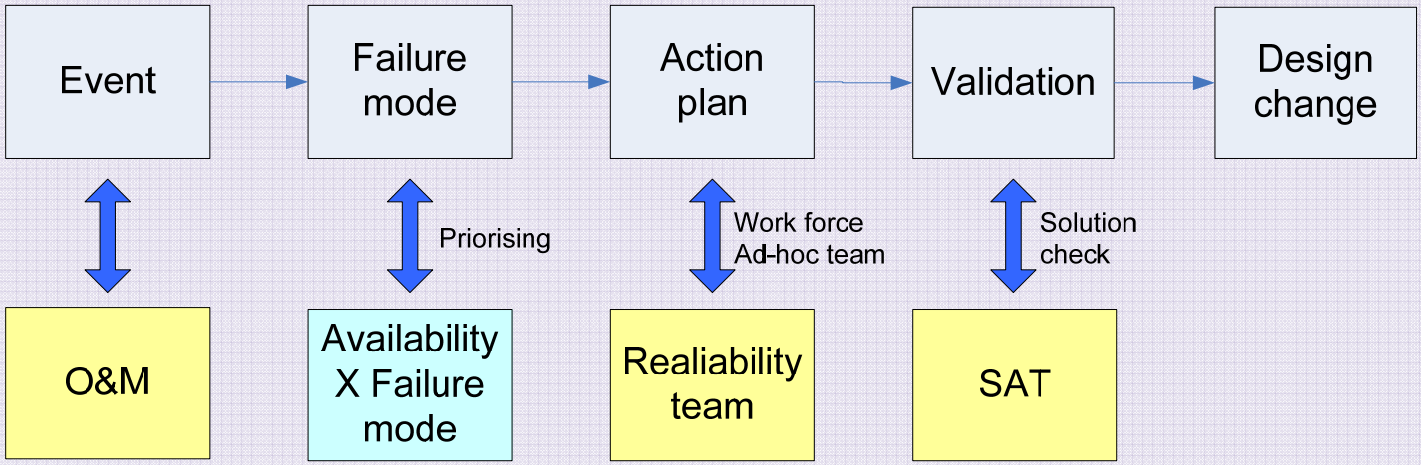
Design Modifications



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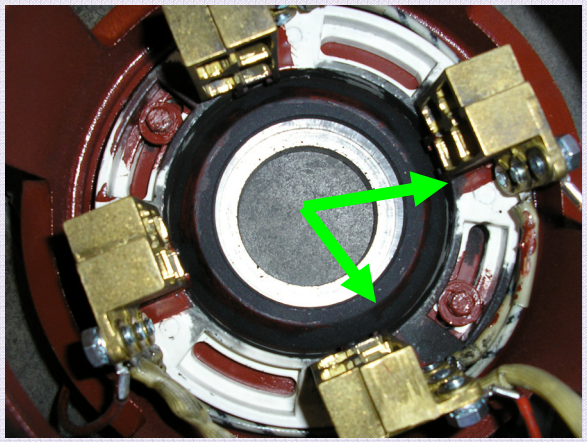
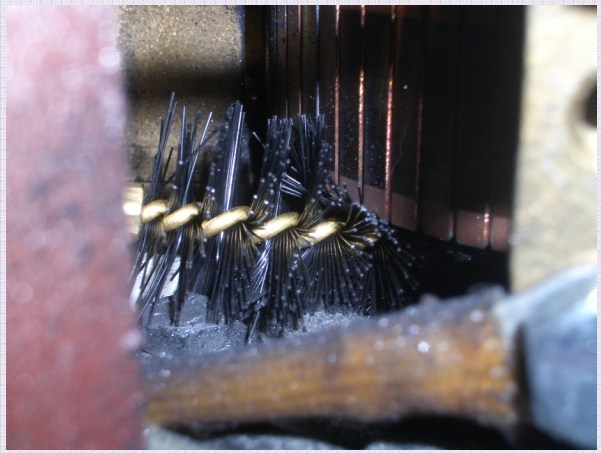
Enhanced Proceedings

- Pitch motor cleaning





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Keys of the process

- Exhaustive and strict periodicity data collection and elaboration
- Site and type sensitive detailed analysis
- Priority by impact and cost
- Action plans defined interdisciplinary and transversal into the organization
- Solutions validated with “end user” criteria or data from the process
- Cost effective extension

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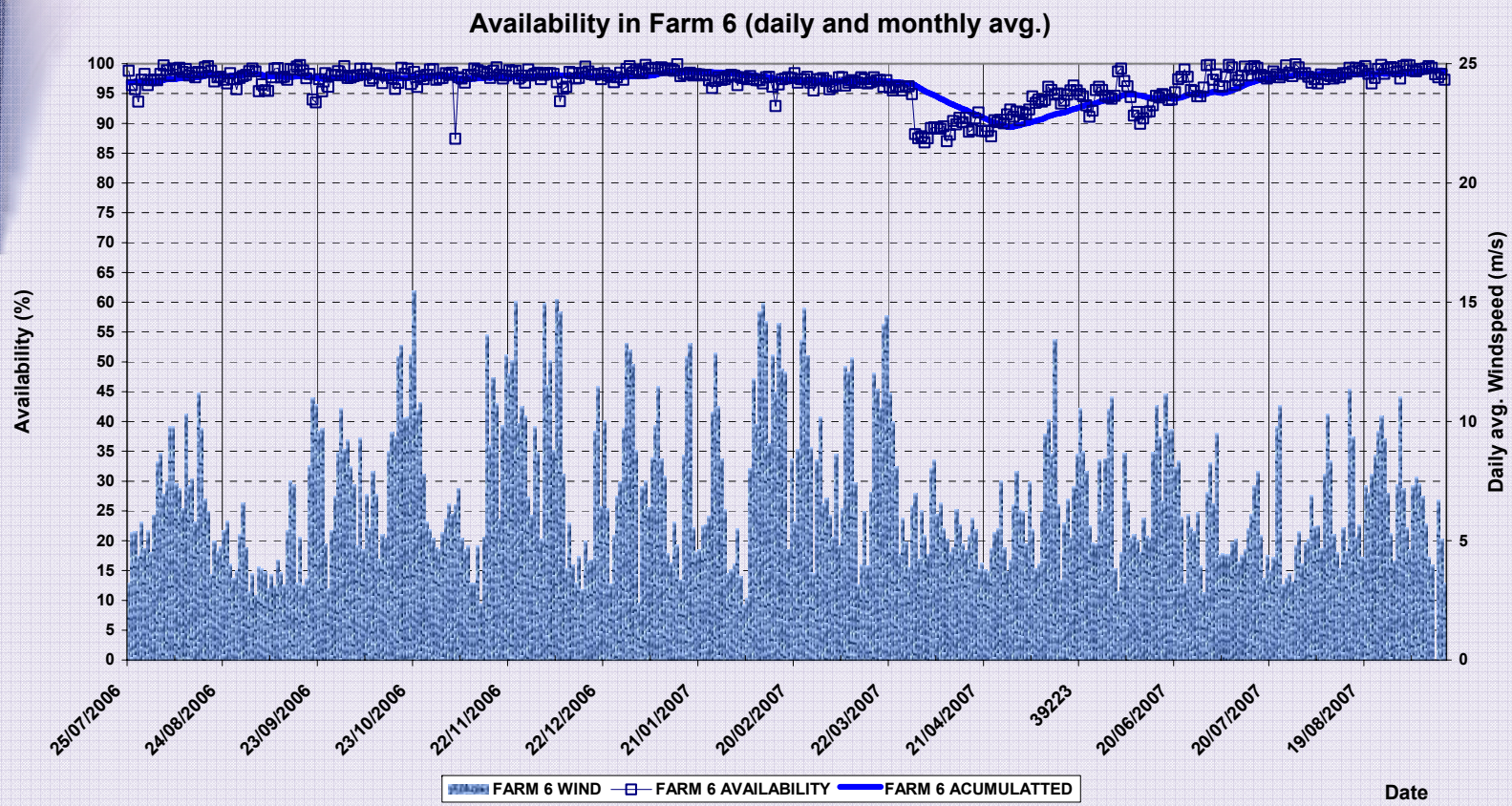
Trouble Input and Output



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Conclusion

- To use availability track as a global indicator
- To itemize data in detailed Failure modes to drive the actions

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Benefits

- Focused on the production Farms and Customer needs
- Optimize organization efforts, giving a common target
- Valid for both product stabilization and full lifecycle reliability
- And move the organization …

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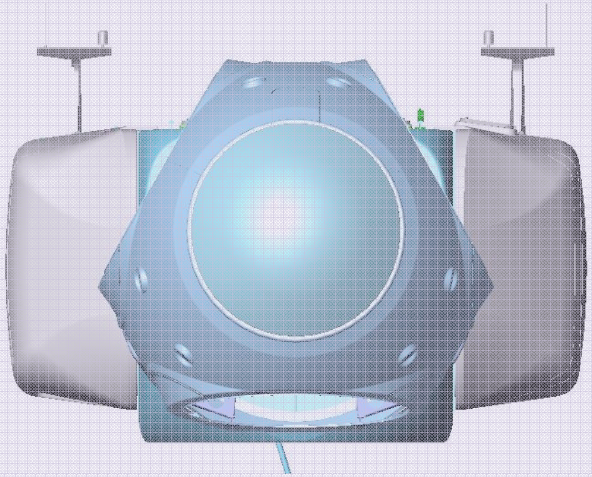
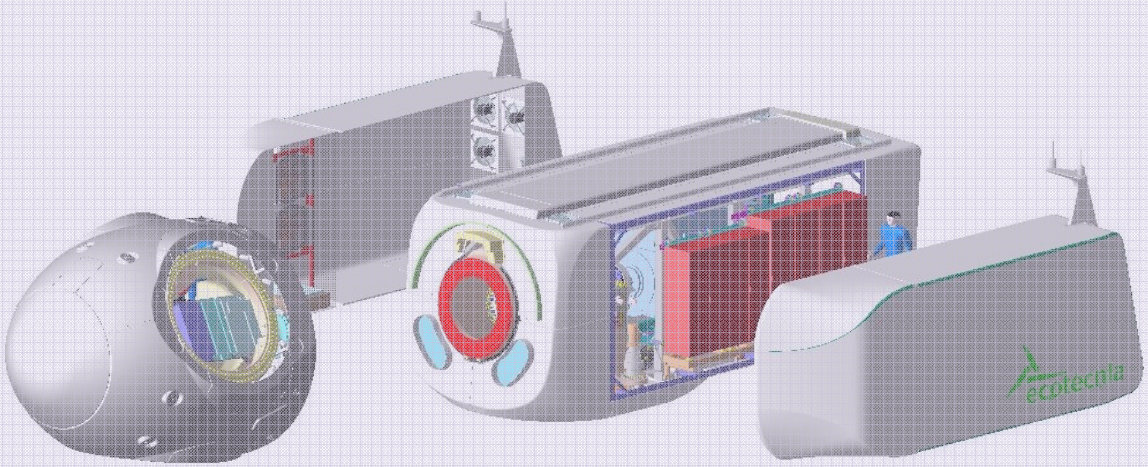
To get better products





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